

What is claimed is :

1. A computer implemented method for development profile simulation comprising:

calculating optical intensities in a photosensitive resist;

5 calculating a spatial average value of the optical intensities;

reading a measured changing ratio of a dissolution rate of the photosensitive resist relating to an alkaline concentration changed by at least one of exposure dose on the photosensitive resist, a position in the thickness direction of the photosensitive resist and an alkaline concentration of developer for the photosensitive resist;

obtaining a calculated dissolution rate by using the spatial average value and the measured changing ratio; and

15 predicting a pattern shape of the photosensitive resist from the calculated dissolution rate.

2. The method of claim 1, wherein the optical intensities is an aerial image intensity.

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3. The method of claim 1, wherein the optical intensities is concentration of photoreaction products.

4. The method of claim 1, wherein the measured changing ratio of the dissolution rate is calculated from a logarithm of a measured dissolution rate to the alkaline concentration.

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5. The method of claim 1, wherein the measured changing ratio of the dissolution rate is calculated from a logarithm of a measured dissolution rate to a logarithm of the alkaline concentration.

6. The method of claim 1, wherein the spatial average value is calculated in an area where the photosensitive resist dissolves in initial stage of development.

7. The method of claim 1, wherein the spatial average is calculated in reference positions moving along development time, which is different from the position where the pattern shape of the photosensitive resist is predicted.

8. A computer implemented method for development profile simulation comprising:

calculating optical intensities in a photosensitive resist;
calculating a spatial average value of the optical intensities;

obtaining a changing ratio of a logarithm of a measured dissolution rate to an alkaline concentration of developer for the photosensitive resist or the changing ratio of the logarithm of the measured dissolution rate to a logarithm of the alkaline concentration of developer for the photosensitive resist;

obtaining a calculated dissolution rate by using the spatial

average value and the calculated changing ratio of the logarithm of the measured dissolution rate to alkaline concentration of a developer or the calculated changing ratio of the logarithm of the measured dissolution rate to the
5 logarithm of an alkaline concentration of the developer; and
predicting a pattern shape of the photosensitive resist by using the calculated dissolution rate.

9. The method of claim 8, wherein the optical intensities is an
10 aerial image intensity.

10. The method of claim 8, wherein the optical intensities is concentration of photoreaction products.

15 11. The method of claim 8, wherein the spatial average value is calculated in an area where the photosensitive resist dissolves in initial stage of development.

12. The method of claim 8, wherein the spatial average is
20 calculated in reference positions moving along development time, which is different from the position where the pattern shape of the photosensitive resist is predicted.

13. A computer implemented method for development profile
25 simulation comprising:

calculating optical intensities in a photosensitive resist;

calculating a spatial average value of the optical intensities in an area where the photosensitive resist dissolves in initial stage of development;

reading a measured changing ratio of a dissolution rate of
5 the photosensitive resist relating to an alkaline concentration;

obtaining a calculated dissolution rate by using the spatial average value and the measured changing ratio; and

predicting a pattern shape of the photosensitive resist by using the calculated dissolution rate.

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14. The method of claim 13, wherein the optical intensities is an aerial image intensity.

15. The method of claim 13, wherein the optical intensities is
15 concentration of photoreaction products.

16. The method of claim 13, wherein the measured changing ratio of the dissolution rate is calculated from a logarithm of a measured dissolution rate to the alkaline concentration.

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17. The method of claim 13, wherein the measured changing ratio of the dissolution rate is calculated from a logarithm of a measured dissolution rate to a logarithm of the alkaline concentration.

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18. The method of claim 13, wherein the spatial average is

calculated in reference positions moving along development time, which is different from the position where the pattern shape of the photosensitive resist is predicted.

5 19. A computer implemented method for development profile simulation comprising:

calculating optical intensities in a target position to predict a pattern shape of a photosensitive resist and reference positions moving along development time;

10 calculating spatial average values of the optical intensities in the reference positions;

reading a measured changing ratio of a dissolution rate of the photosensitive resist relating to the alkaline concentration;

15 obtaining calculated dissolution rates by using the spatial average values in the reference positions and the measured changing ratio; and

predicting the pattern shape of the photosensitive resist in the target position by using the calculated dissolution rates
20 and the optical intensities in the target position.

20. The method of claim 19, wherein the optical intensities is an aerial image intensity.

25 21. The method of claim 19, wherein the optical intensities is concentration of photoreaction products.

22. The method of claim 19, wherein the measured changing ratio of the dissolution rate is calculated from a logarithm of a measured dissolution rate to the alkaline concentration.

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23. The method of claim 19, wherein the measured changing ratio of the dissolution rate is calculated from a logarithm of a measured dissolution rate to a logarithm of the alkaline concentration.

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24. The method of claim 19, wherein the spatial average value is calculated in an area where the photosensitive resist dissolves in initial stage of development.

15 25. A computer program product for controlling a computer system so as to simulate development profile, the computer program product comprising:

instructions configured to calculate optical intensities in a photosensitive resist within the computer system;

20 instructions configured to calculate a spatial average value of the optical intensities within the computer system;

instructions configured to read a measured changing ratio of a dissolution rate of the photosensitive resist relating to an alkaline concentration changed by at least one of exposure
25 dose on the photosensitive resist, a position in the thickness direction of the photosensitive resist and an alkaline

concentration of developer for the photosensitive resist within the computer system;

instructions configured to obtain a calculated dissolution rate by using the spatial average value and the measured
5 changing ratio within the computer system; and

instructions configured to predict a pattern shape of the photosensitive resist from the calculated dissolution rate within the computer system.

10 26. A computer program product for controlling a computer system so as to simulate development profile, the computer program product comprising:

instructions configured to calculate optical intensities in a photosensitive resist within the computer system;

15 instruction configured to calculate a spatial average value of the optical intensities within the computer system;

instruction configured to obtain a changing ratio of a logarithm of a measured dissolution rate to an alkaline concentration of developer for the photosensitive resist or the
20 changing ratio of the logarithm of the measured dissolution rate to a logarithm of the alkaline concentration of the developer for the photosensitive resist within the computer system;

instruction configured to obtain a calculated dissolution
25 rate by using the spatial average value and the calculated changing ratio of the logarithm of the measured dissolution

rate to alkaline concentration of the developer or the
calculated changing ratio of the logarithm of the measured
dissolution rate to the logarithm of the alkaline concentration
of the developer within the computer system; and

5 instruction configured to predict a pattern shape of the
photosensitive resist by using the calculated dissolution rate
within the computer system.

27. A computer program product for controlling a computer
10 system so as to simulate development profile, the computer
program product comprising:

instruction configured to calculate optical intensities in a
photosensitive resist within the computer system;

instruction configured to calculate a spatial average value
15 of optical intensities in an area where the photosensitive
resist dissolves in initial stage of development within the
computer system;

instruction configured to read a measured changing ratio of
a dissolution rate of the photosensitive resist relating to an
20 alkaline concentration within the computer system;

instruction configured to obtain a calculated dissolution
rate by using the spatial average value and the measured
changing ratio within the computer system; and

instruction configured to predict a pattern shape of the
25 photosensitive resist by using the calculated dissolution rate
within the computer system.

28. A computer program product for controlling a computer system so as to simulate development profile, the computer program product comprising:

5 instruction configured to calculate optical intensities in a target position to predict a pattern shape of a photosensitive resist and reference positions moving along development time within the computer system;

 instruction configured to calculate spatial average values
10 of the optical intensities in the reference positions within the computer system;

 instruction configured to read a measured changing ratio of a dissolution rate of the photosensitive resist relating to the alkaline concentration within the computer system;

15 instruction configured to obtain calculated dissolution rates by using the spatial average values in the reference positions and the measured changing ratio within the computer system; and

 instruction configured to predict the pattern shape of the
20 photosensitive resist in the target position by using the calculated dissolution rates and the optical intensities in the target position within the computer system.

29. A computer implemented method for mask pattern data
25 correction comprising:

 reading a designed pattern data in a photosensitive

resist, a mask pattern data, and a measured changing ratio of
a dissolution rate of the photosensitive resist relating to an
alkaline concentration changed by at least one of exposure
dose on the photosensitive resist, a position in the thickness
5 direction of the photosensitive resist and an alkaline
concentration of developer for the photosensitive resist;

calculating optical intensities in the photosensitive resist
by using the mask pattern data;

calculating a spatial average value of the optical
10 intensities;

obtaining a calculated dissolution rate by using the spatial
average value and the measured changing ratio;

predicting a pattern shape of the photosensitive resist from
the calculated dissolution rate; and

15 optimizing the mask pattern data so as to make the
calculated pattern shape similar to the designed pattern data
in the photosensitive resist.

30. A computer implemented method for mask pattern data
20 correction comprising:

obtaining a designed pattern data in a photosensitive resist,
a mask pattern data, and a calculated changing ratio of a
logarithm of a measured dissolution rate to an alkaline
concentration of developer for the photosensitive resist or the
25 calculated changing ratio of the logarithm of the measured
dissolution rate to a logarithm of the alkaline concentration of

developer for the photosensitive resist;

calculating optical intensities in the photosensitive resist
by using the mask pattern data;

calculating a spatial average value of the optical
5 intensities;

obtaining a calculated dissolution rate by using the spatial
average value and the measured changing ratio;

predicting a pattern shape of the photosensitive resist from
the calculated dissolution rate; and

10 optimizing the mask pattern data so as to make the
calculated pattern shape similar to the designed pattern data
in the photosensitive resist.

31. A computer implemented method for mask pattern data
15 correction comprising:

reading a designed pattern data in a photosensitive resist,
a mask pattern data, and a measured changing ratio of a
dissolution rate of the photosensitive resist relating to an
alkaline concentration;

20 calculating optical intensities in the photosensitive resist
by using the mask pattern data;

calculating a spatial average value of optical intensities in
an area where the photosensitive resist dissolves in initial
stage of development;

25 obtaining a calculated dissolution rate by using the spatial
average value and the measured changing ratio;

predicting a pattern shape of the photosensitive resist from the calculated dissolution rate; and

optimizing the mask pattern data so as to make the calculated pattern shape similar to the designed pattern data
5 in the photosensitive resist.

32. A computer implemented method for mask pattern data correction comprising:

reading a designed pattern data in a photosensitive resist,
10 a mask pattern data, and a measured changing ratio of a dissolution rate of the photosensitive resist relating to the spatial average value;

calculating optical intensities in a target position of the photosensitive resist and reference positions moving along
15 development time by using the mask pattern data;

calculating a spatial average value of the optical intensities in the reference positions;

obtaining a calculated dissolution rate by using the spatial average value in the reference positions and the measured
20 changing ratio;

predicting a pattern shape of the photosensitive resist by using the calculated dissolution rate and the optical intensities in the target position; and

optimizing the mask pattern data so as to make the
25 calculated pattern shape similar to the designed pattern data in the photosensitive resist.